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ABSTRACT

This study was undertaken to investigate the relative effectiveness of two instructional options offered at City High School, Iowa City. Students enrolled in algebra and geometry courses at this school may elect to participate in a self-paced Program using learning packets, pretests and posttests developed by the faculty, or to be taught by traditional classroom methods. For all students completing these courses in 1974 or 1975, the following data were obtained from school records: grades for ninth-grade algebra (taught by traditional methods in junior high schools), high school algebra and geometry grades, ACT Mathematics score, Iowa Tests of Educational Development (ITED) - Quantitative score. These scores were submitted to several analyses of variance and covariance in order to test possible relationships among the variables. No significant difference on ACT scores was found for the two instructional methods when scores were adjusted for initial ability as measured by ITED or grade in ninth-grade algebra. However, it was observed that high-ability students were more likely to select the self-paced program, and to take more mathematics. The author notes several other relationships, but states that conclusive evaluation can not be achieved without further research. (SD)

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SE

TO: David L. Cronin
Iowa City Community School
District Coordinator

Wesley A Erbe
University Coordinator

FROM: Harold L. Schoen
Education and Mathematics
The University of Iowa

DATE: April 30, 1975

A copy of the final report of the evaluation of the self paced mathematics program at City High School is enclosed. The results are not as definitive as one might like them to be, but I trust some of the findings will be useful. I have enjoyed the opportunity to work with the City High School mathematics faculty on this project. I hope that the University of Iowa and the Iowa City Schools will continue to cooperate in similar efforts.

cc: John McAdam
Secondary Education

Gene Nelson
City High School
Mathematics Department

SE019 077

EVALUATION OF THE INDIVIDUALIZED APPROACH TO MATHEMATICS INSTRUCTION AT CITY HIGH SCHOOL

FINAL REPORT

by

Harold L. Schoen

The University of Iowa

April, 1975

Introduction

The Mathematics Department at City High School, Iowa City, Iowa, has been using an individualized unit approach to mathematics instruction for approximately seven years. This approach has been offered to students as an optional alternative to the traditional classroom methods. A degree of individualization is achieved by allowing students to proceed at their own pace through a sequenced set of learning packets prepared by members of the City High faculty. A student moves from one unit to the next by passing a pretest and/or posttest of each unit. The time it takes students to complete a course in this manner is allowed to vary though each student is expected to master essentially the same content that the traditional class includes.

In December, 1975, a proposal to evaluate this instructional approach was approved by the University of Iowa Coordinator and the Iowa City Community School District Coordinator. This paper is the final report of that evaluation.

Problem Statement

At the outset, the major question to be answered by this evaluation was: Has the self paced approach to mathematics instruction been as effective as the traditional classroom approach? In addition, does the student's entering achievement level affect his ability to learn by one method as compared to the other?

Several other questions were examined when the trends in the data indicated they might be of interest. These are the following:

(1) Is the student's choice of method related to his entering mathematical

ability, the junior high attended, or the student's sex?

(2) How closely related are the measures of aptitude and achievement collected on each student?

(3) Does the 1974 class differ significantly from the 1975 class on any of the variables examined?

(4) Do students who were in the self paced program in geometry but not in algebra differ from those for which the reverse was true?

Procedure

The graduating class of 1974 was the first class to have the option of self pacing in all three years of high school. For this reason, data for the graduating classes of 1974 and 1975 only were collected from the school records. The data included junior high school attended, sex, ninth grade algebra grade, ITED Quantitative score from grade 9, ACT Mathematics score, and the treatment group (self paced or traditional) for geometry 1, geometry 2, and advanced algebra (algebra 3 and algebra 4). If data were available in any of the last four categories, the student was included in the sample. In all, the sample was comprised of 503 students, 236 in the 1974 and 267 in the 1975 class.

These data were then analyzed in an attempt to answer the aforementioned questions. In particular, the ninth grade algebra grade and the ninth grade ITED Quantitative score were considered as entry data and the ACT Mathematics score was the criterion measure. Since the ACT test is taken during the student's senior year, the teaching method in senior mathematics class was not considered. In addition, because the data were collected in December, 1974, only those students in the 1975 class who took the ACT test in Fall, 1974,

were included in the test of group differences.

Typically, data on each student would include the following.

Grade 9 - algebra 1 and 2 grade, ITED Quantitative score
Grade 10 - geometry 1 and 2 treatment levels
Grade 11 - algebra 3 and 4 treatment levels
Grade 12 - ACT Mathematics score

Results

To make this section read as clearly as possible, only the main findings of the analysis, not a detailed report of the results of the statistical tests, are included here.

Correlations of Measures

The three measures to be used in the analysis--ninth grade algebra scores, ninth grade ITED Quantitative scores, and ACT Math scores--were highly correlated as Table 1 indicates. These correlation coefficients were computed using only those students for whom the scores were available. Since many students do not take the ACT and every junior high did not administer the ITED in ninth grade, the numbers are considerably less than the total sample.

Table 1

Pearson Product Moment Correlations

	ITED Quantitative	ACT Math
Algebra, 9th Grade	.88[a]	.81[b]
ITED Quantitative		.94[a]

a - computed with N=193
b - computed with N=255

Comparability of Ninth Grade Algebra Grades

Ninth grade algebra grades were available for nearly all students in the sample, while ninth grade ITED Quantitative scores were missing for many students. For instance, of the 257 students who took the ACT Math test, ninth grade algebra grades were available for all but two while ninth grade ITED scores were listed for only 193. Since the Algebra 1 and 2 grades and the ITED Quantitative scores had an estimated .88 correlation, the grade was used as a measure of past mathematics achievement or aptitude. To further justify this decision a one way analysis of variance was computed using ninth grade algebra grades as the criterion measure. The three groups compared were the students who had attended Southeast Junior High School, Central Junior High School and other junior highs, respectively. The means, standard deviations and numbers of students in each group are listed in Table 2. The means did not differ significantly (.05 probability level). It was concluded that grading policies were very similar in three junior high groupings.

Table 2

Junior High Algebra Grades*

Central Junior High	Southeast Junior High	Other Junior Highs
$\bar{x}$ = 2.4	$\bar{x}$ = 2.6	$\bar{x}$ = 2.6
S.D. = .90	S.D. = .95	S.D. = .89
N = 131	N = 340	N = 32

*Based on a 4-point grading scale

The proportion of students choosing to take either geometry or advanced algebra did not differ significantly across junior high groups either. These proportions are listed in Table 3.

Table 3

Proportions Taking Geometry or Advanced Algebra

	Central Junior High	Southeast Junior High	Other Junior Highs
Number taking geometry or advanced algebra	99	241	25
Total Number	132	340	34
Proportion	.75	.71	.74

Students Completing Self Paced Courses

Of the 365 students who took either geometry or advanced algebra at City High School, 247 completed at least one semester in the self paced program. The proportion of boys choosing self pacing did not differ significantly from the proportion of girls nor did the proportions differ significantly among the three junior high school groups. This conclusion is based on a chi square test of differences of proportions. The findings are summarized in Table 4.

Table 4

Students Completing at Least One Semester of Self Paced Mathematics

	Central Junior High	Southeast Junior High	Other Junior Highs
Boys	Yes - 39 No - 15	Yes - 77 No - 50	Yes - 8 No - 0
Girls	Yes - 32 No - 13	Yes - 78 No - 36	Yes - 13 No - 4

Achievement in Self Pacing Versus Traditional

Since data were missing for many students and some students completed only one semester of geometry or advanced algebra while others completed all four, meaningful comparisons of the ACT Mathematics scores of the self paced versus traditional groups are very difficult to make. This difficulty is compounded by the widely differing entering ability of the two groups, i.e., the students completing at least some self paced mathematics had, on the average, much higher ninth grade algebra letter grades.

In view of these difficulties, comparisons were made in two ways. The first was to make an overall comparison of the ACT Mathematics scores of three groups of students. These groups were formed by first eliminating all students who failed to complete even one semester of geometry or advanced algebra or whose ACT Mathematics score was not available. Then, of the remaining students those who had completed only self paced mathematics regardless of how many semesters or whether it was algebra or geometry were placed in Group 1. Those who had completed at least one semester in self pacing and at least one semester in the traditional classroom were placed in Group 2. Finally, those who had completed only traditionally taught mathematics were placed in Group 3. In order to allow for the differences in entering ability among the three groups, ninth grade algebra grades were used as a covariate with ACT Mathematics scores as the criterion measure. Analysis of covariance is a statistical technique which compares the ACT Mathematics means of the three groups after adjusting for initial differences in the covariate. A 2x3 factorial design was employed which also tested for differences between the 1974 and 1975 classes as well as interactions between the teaching method and year--1974 or 1975.

The means, standard deviations and numbers in each cell are listed in Table 5. The results of the analysis of covariance showed no significant differences between the ACT Mathematics means of the 1974 and 1975 students or among the teaching methods or any combinations of year or method after initial differences were taken into account. However, note that Group 3, traditional only, had lower ninth grade algebra grades than either of the other two groups. This is shown clearly in Figure 1.

Table 5

Means and Standard Deviations of Treatment Groups

	1974		1975	
	9th Algebra Grade	ACT Math.	9th Algebra Grade	ACT Math.
Group 1	$\bar{x}$ = 2.8 S.D. = .65 N = 78	$\bar{x}$ = 20.9 S.D. = 4.62	$\bar{x}$ = 3.1 S.D. = .77 N = 47	$\bar{x}$ = 24.7 S.D. = 5.88
Group 2	$\bar{x}$ = 3.2 S.D. = .76 N = 39	$\bar{x}$ = 26.4 S.D. = 3.84	$\bar{x}$ = 3.1 S.D. = .87 N = 19	$\bar{x}$ = 24.2 S.D. = 5.74
Group 3	$\bar{x}$ = 2.3 S.D. = .83 N = 50	$\bar{x}$ = 18.6 .D. = 5.63	$\bar{x}$ = 2.6 S.D. = .96 N = 22	$\bar{x}$ = 19.5 S.D. = 6.37

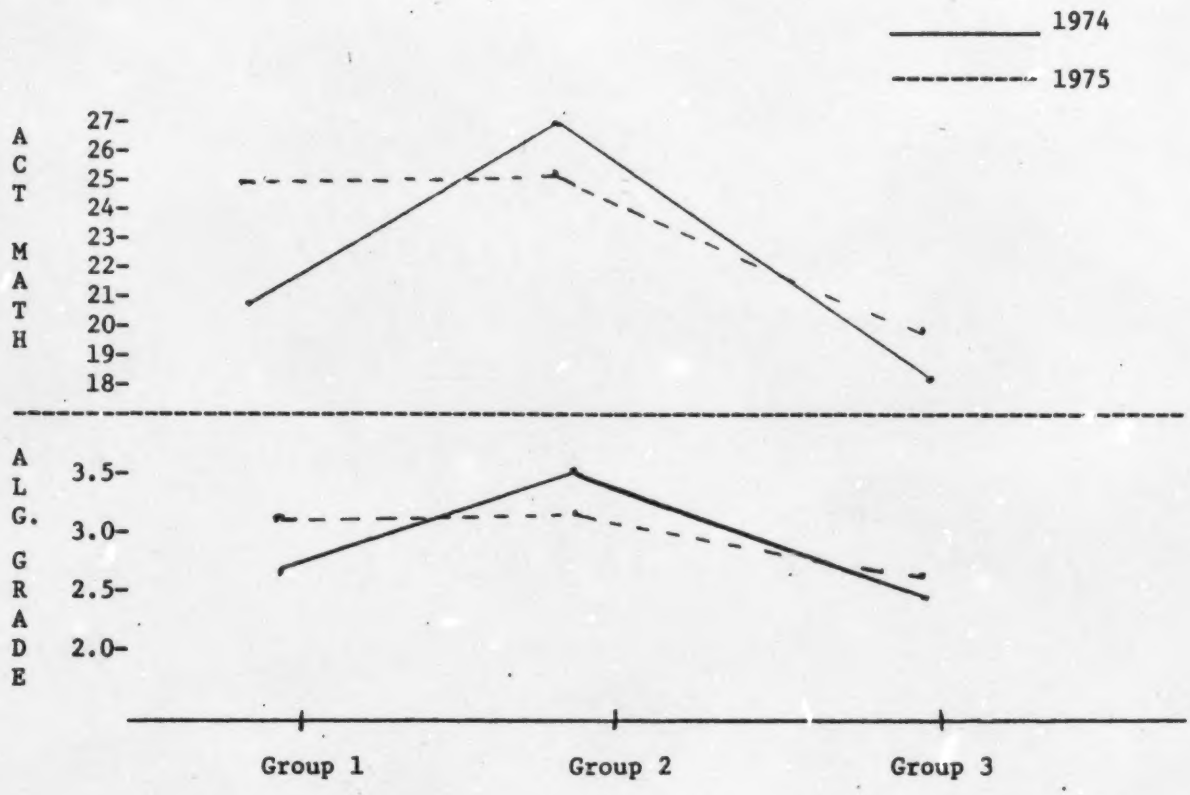

Figure 1

Obviously, since the students in the groups varied according to the number of semesters of mathematics completed as well as in other ways including the method by which they learned mathematics, comparison of the above groups can give little more than a clear indication that the entering ability of students in Group 3 is below that of the other two groups.

In an attempt to isolate a possible methods effect, a similar comparison was made with only those students who completed at least three semesters of algebra and geometry at City High School. Allowing for initial differences in the covariate, there was again no significant difference between the groups taught entirely by self pacing and those taught entirely in the traditional classroom. Again, the self paced students were the better students as measured

by their junior high algebra grades. The results are summarized in Table 6

Table 6

Means and Standard Deviations of
Students with at Least Three Semesters of Mathematics

Self Paced		Traditional	
9th Algebra Grade	ACT Mathematics	9th Algebra Grade	ACT Mathematics
$\bar{x}$ = 3.4	$\bar{x}$ = 26.8	$\bar{x}$ = 2.7	$\bar{x}$ = 23.6
S.D. = .61	S.D. = 4.64	S.D. = .82	S.D. = 5.67
N = 40		N = 15	

Students who completed at least three semesters of geometry and advanced algebra with a mixture of methods were also examined. It is interesting to note that four times as many students completed geometry traditionally and advanced algebra in the self paced program than vice versa. In addition, the ACT Math mean of the "geometry-traditional and algebra-self paced" group was significantly higher than the other group ($t=2.53$, $p < .05$) although entering algebra grades of the two groups were equal on the average. The means and standard deviations are listed in Table 7.

Table 7

Students with at Least Three Semesters
of Mathematics and a Combination of Methods

Geometry-Traditional Algebra-Self Paced		Geometry-Self Paced Algebra-Traditional	
9th Algebra Grades	ACT Math	9th Algebra Grades	ACT Math
$\bar{x}$ = 3.3	$\bar{x}$ = 26.6	$\bar{x}$ = 3.3	$\bar{x}$ = 22.8
S.D. = .77	S.D. = 4.03	S.D. = .93	S.D. = 5.49
N = 44		N = 11	

Conclusions

The question of whether the self paced approach has been as effective as the traditional approach is left unanswered by these findings. There is no evidence to indicate a significant difference in ACT Mathematics scores adjusted for initial differences between students taught by the respective methods over the last two years. On the other hand, there is clear evidence that students of lower ability do not complete geometry or algebra in the self paced program. This is both by choice and by an inability to function in the individualized classroom. However, the choice of method is not related to the student's sex or the junior high school attended.

Junior high school algebra grading policies appeared to be consistent from one junior high to the next. These grades were also closely related to ninth grade ITED Quantitative scores and ACT Mathematics scores, and thus appeared to be a reliable measure of a student's mathematical achievement upon entering

high school. Similarly, the graduating class of 1974 did not differ significantly from that of 1975 as compared by adjusted ACT Mathematics scores.

There were four times as many students who completed geometry in the traditional classroom and switched to individualized algebra than students for whom the reverse was true. In addition, the former group scored significantly higher on the ACT Mathematics test even after allowing for initial achievement differences. This particular observation involves only about one tenth of the students in the original sample and may not have real significance. However, it may be that algebra is easier to learn via the individualized approach than geometry is. Nearly all of the students in the sample completed geometry before advanced algebra, but beginning in 1974-75 the courses will be reversed. Perhaps the fact that the students in the sample were, for the most part, new to the individualized method in geometry may also help explain this difference. At any rate, it should be interesting to see if the same difference occurs with students in geometry who have an extra year of algebra as well as a year to become familiar with the self paced approach.

This evaluation cannot be considered to be conclusive. It shows no evidence of the superiority of either teaching approach. While it does provide some useful information, the reasons for the findings can never be established by a "backward" look at the program. A more useful (as well as more difficult and expensive to conduct) approach would be to take an in-depth look at various aspects of the program while it is in operation. Variables to observe should include growth in student achievement, student attitude, teacher attitude, teacher work load, student transfer, and retention of concepts, detailed performance of individual students and many others. The list

of interesting questions is almost unlimited. Until such a study is completed, the present findings suggest that the self paced program has at least not hurt student achievement, although weaker students either cannot or do not complete their mathematics in the individualized classroom, and geometry may, in fact, be more difficult to learn in this manner than algebra.